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USSR REPORT

ELECTRONICS AND ELECTRICAL ENGINEERING

No. 98

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TRIODE OSCILLATOR SUBJECT TO NOISE

VAKMAN, D. Ye.

[Abstract] Modulation noise in a triode oscillator, namely flicker noise,
is analyzed in the second-order approximation. Regarded as a normal station-
ary $\omega^{-\lambda}$-process, its principal effect is to alter the transconductance of the
tube. Low-frequency flicker within the $0 < \omega < 1$ band is found to cause both
slow static and fast dynamic fluctuations of the instantaneous frequency.
High-frequency flicker within the $1 < \omega < 3$ band is found to be reducible to
additive noise, but much weaker than thermal and shot noise. Analytical ex-
pressions for the signal and the spectrum are derived on this basis, for use
in the oscillator equations and in the design of filters. Figures 1;
references: 5 Russian.
[91-2415]

OPTIMAL OUTFITTING OF INSTRUMENTS FOR MEASUREMENT IN PARTIALLY NON-WHITE
OBSERVATION NOISE

YARLYKOV, M. S. and MIRONOV, M. A.

[Abstract] The problem of outfitting instruments optimally with respect to
accuracy and efficiency is treated from the standpoint of the general theory
of conditional Markov processes, of particular interest being the case where
some vector diffusion process distorts part of the white background noise.
The complex of random processes observed during a given time interval is
represented as the sum of two vector-columns. The non-white noise is described

by a first-order stochastic vector differential equation with the time derivative of the noise vector equal to the sum of two vector functions continuous in all arguments and continuously differentiable with respect to all arguments except time. Optimal and quasi-optimal algorithms for complex processing of data are constructed on this basis. The simplest set of two first-order quasi-optimal algorithms is demonstrated on a set of two instruments for primary processing of data where a process

$$\xi_1(t) = \frac{dy}{dt}1 = s(t,x_1) \text{ signal } +$$

$+ \sqrt{1/2N_1}\ n_1(t)$ noise appears at the input of the first one and a process

$\xi_2(t) = y_2(t) = x_1(t) + u(t)$ is to appear at the output of the second one. The optimum instrument set constitutes a nonlinear filter with two inputs consisting of a discriminator, three filters and three corresponding amplifiers, two adders and a high-speed signal shaper. The algorithms can be constructed in the form of difference rather than differential equations, for implementation on a digital computer. They can be modified for various forms of Markov processes, also for measurements with a priori indeterminacy. Figures 1; references 9: 8 Russian, 1 Western (in translation).
[91-2415]

ALGORITHM FOR DETECTING TRAJECTORIES AND ESTIMATING COORDINATES OF MOVING OBJECT

LEVIN, B. R., TEGINA, N. V. and YUDITSKIY, A. I.

[Abstract] The multialternative problem of simultaneously detecting and estimating several signals, namely trajectories and coordinates of a moving object, is solved by the Bayes method without resorting to the theory of random signal fluxes. The loss function is considered with the number of estimates ĉ either larger than the number of signals c (arbitrary extra estimates) or equal to or smaller than the number of signals c. The algorithm is demonstrated on signals representable as polynomials, specifically two trajectories with probability distributions $P(c = 2) = 0.7$, $P(c = 1) = 0.3$, $P(c = 0) = 0$. The signals are assumed to correspond to the same hypothesis, a constant. The systematic error of this algorithm and the dispersion of errors are calculated, by averaging the estimation errors, for a sample size n = 5 with $\sigma^2_{meas} = 1$ and an $f(c,\hat{c}) = \sigma^2_{meas}(c - c)^2$ component of the loss function associated with estimating the number of signals, assuming a uniform noise distribution. References 7: 5 Russian, 2 Western (1 in translation).
[91-2415]

NONLOCAL NATURE OF SOME EFFECTS OBSERVED DURING DISTANCE OCEAN SOUNDING

KRAVTSOV, Yu. A. and ETKIN, V. S., Physical Institute imeni P. N. Lebedev,
USSR Academy of Sciences

[Abstract] The authors note that customarily it is assumed that effects
observed with the aid of distance methods (microwave and laser Scatterometry,
microwave and infrared radiometry) have a local nature, i.e., they appear
just where perturbation factors proceed. Examples of such factors are petro-
leum films, output of internal waves (slick) and local currents. Also, in
a number of cases nonlocal effects appear, caused by the fact that, to start
with, the initial perturbation modifies the energy carrying components of the
seaways, and the changes of the waves are observed afterwards beyond the action
of the perturbation. In the present brief communication consideration is
given to the possibility of a simple model description of nonlocal effects of
the basis of transfer equations and the possibility connected with them of
obtaining additional information on the dynamic characteristics of seaways.
The following items are studied: 1) Transfer equations for energy of seaways;
2) Solution of transfer equation in the case of small perturbations; and
3) Time effects. Figures 1; references 4: 2 Russian, 2 Western.
[29-6415]

PROPAGATION OF SHORT PERIODIC WAVES IN IONOSPHERE

SOROKIN, V. M. and FEDOROVICH, G. V., All-Union Scientific-Research Institute
of Optical-Physical Measurements

[Abstract] In order to verify certain assumptions that have been advanced
as well as to investigate the propagation characteristics of short-periodic
waves in the atmosphere, the present paper analyzes records concerned with
the geomagnetic field. These records were obtained during various geomagnetic
observations in an interval of time on the order of 30 minutes after violent
earthquakes. Also analyzed were records of a geometrical field obtained during
observations in areas of the Pacific Ocean and the USA. During processing of
experimental data, short-periodic waves were shown to propagate in the low
ionosphere with a velocity on the orders of 20 km/s. The pulse function of
these waves is found and an analysis is made. The properties of theoretically
calculated short-periodic shock waves of a geomagnetic field are found in full
accordance with the results obtained during analysis of experimental data.
Figures 8; tables 1; references 20: 10 Russian, 10 Western.
[29-6415]

DIFFERENCE OF RESPONSE OF IONOSPHERE F_2 REGION TO ACTION OF INTERNAL
GRAVITATIONAL WAVES UNDER DAYTIME AND NIGHTTIME CONDITIONS

SMERTIN, V. M. and NAMGALADZE, A. A., Kaliningrad State University

[Abstract] On the basis of observations cited in the literature, the
authors note that moving ionospheric perturbations resulting from internal

gravitational waves (IGW) develop in different ways into day and night high-level profiles of electron concentration N_e at the F2-region of the ionosphere. In the daytime significant deformations are possible of the high-level profiles of N_e with the appearance of stratifications and noticeable changes at the half-thickness of the layer. At night the F2 layer moves as a unit, not changing substantially the form of the high-level profile N_e. This difference in the reaction of the day and night F2 region to the passage of IGW also appears in the results of numerical solutions of the problem of the effect of IGW on the atmosphere. A. A. Namgaladze (see above) participated in 5 of the 7 reports cited in the present work. The present brief communication is concerned with an attempt at physical interpretation of the substance of the above phenomena. This interpretation is closely based on the reports from the literature mentioned above. In the text figure 1 presents the high-level profiles Δv_{nx} (v_{nx} = meridional component of the rate of movement of a neutral gas), obtained by numerical solution of a problem concerned with generation of IGW by an aurora electrojet, for the moments of time 60 minutes, 100 minutes and 160 minutes reckoned from the beginning of perturbation. Figure 2 presents the results of calculations of the high-level profiles N_e with the presence of the wave perturbation shown in figure 1. Figures 2; references 7: 5 Russian, 2 Western.
[29-6415]

UDC 621.37/39:534

NONLINEAR INTERACTIONS IN COUPLED WAVEGUIDES WITH SURFACE ACOUSTIC WAVES
PROPAGATING IN OPPOSITE DIRECTIONS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82
(manuscript received 3 Apr 81) pp 2056-2058

ZHGUN, S. A. and SHTYKOV, V. V.

[Abstract] Nonlinear interaction of surface acoustic waves propagating in opposite directions through coupled waveguides was studied experimentally. A specimen of such a pair of waveguides was built on a YZ-cut LiNbO$_3$ substrate with aluminum coating. Surface acoustic waves were excited by means of interdigital transducers with an f_0 = 47 MHz center frequency and fed to the waveguide through matching horns. Electric convolution signals, indicators of energy transfer from one waveguide to another under conditions of acoustic nonlinearity, were measured synphasally (both waveguides connected) and antiphasally (one waveguide grounded). Their magnitudes were found to depend on the mutual delay between input radio pulses. Subsequent calculations reveal that the maximum amplitudes of these signals are, depending on the input terminals, either cosine or sine function of the delay time multiplied by the linear waveguides in a convolver, the signal at the center frequency f_0 must be applied immediately to all four inputs. Figures 3; references: 2 Western.
[91-2415]

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NONLINEAR INTERACTION OF ELECTROMAGNETIC WAVES IN SUPERLATTICE

ORLOV, L. K. and ROMANOV, Yu. A., Scientific-Research Physicotechnical
Institute affiliated with Gorkiy University

[Abstract] The nonlinear interaction is investigated of three electromagnetic
waves with frequencies which satisfy the conditions of decay

$$\ell\omega_1 = \omega_2 + \omega_3 \quad \ell = 1, 3, 5$$

where $\omega_{1,2,3}$ are, respectively, the pumping frequency, idler wave and signal,
in a superlattice with a sinusoidal law of dispersion of the energy of
electrons. It is shown that with specific conditions, amplification of the
signal wave in a given pump field can have an explosive nature. The instability
considered in the present paper can be called explosive only with respect to
the nature of the spatial build-up of the signal. It is connected with the
growth of the negative conduction of the superlattice during an increase of
the signal amplitude in a specified pump field. In so doing only one of the
interacting waves increases, and not all, as this takes place in the case of
ordinary instability. Figures 4; references 12: 10 Russian, 2 Western.
[29-6415]

STATISTICAL CHARACTERISTICS OF MILLIMETER WAVES REFLECTED BY VEGETATION

ANDREYEV, T. A., POTAPOV, A. A. and KHOKHLOV, G. I.

[Abstract] A phenomenological model of scattering of millimeter waves by
forests is considered for a theoretical interpretation of experimental data.
A forest covering the ground is regarded as an ensemble of randomly vibrating
scatterers with inertia which affect the time characteristics and the spectrum
of a reflected signal. Measurements were made with equipment consisting of a
radiation source, transmitter-and-receiver antenna, heterodyne oscillator,
mixer, i-f amplifier, i-f detector, envelope detector, low-pass filter and
recording instrument. Signals at 135 GHz frequency were beamed into a birch
(leaf tree) forest and into a pine (needle tree) forest, at wind velocities
up to 7 m/s. A correlation and regression analysis of the data has yielded
a correlation function with a second derivative and a correlation coefficient
decreasing exponentially with increasing correlation time for the intensity of

the scattered field (95% confidence interval 8 ± 0.8 ms for birch trees and 22 ± 2.2 ms for pine trees at wind velocity of 2 m/s). The analysis has also yielded a power spectrum decreasing not slower with increasing frequency than according to the inverse fourth-power law and, on the basis of spectrum width measurements, random modulated by the wind velocity within the $m_V \sim 0.05 - 0.1$ range. Comparative measurements of the effective cross section for scattering have yielded -3 dB for a birch forest and -11 dB for a pine forest during a rain of 2 mm/h intensity and wind of up to 5 m/s velocity. Figures 4; references 12: 10 Russian, 2 Western.
[91-2415]

MULTIMODE INTERFERENCE OF SURFACE LIGHT WAVES IN MICROWAVEGUIDE INTERFEROMETER

OSTROUMENKO, A. P., PRUDKIY, V. P. and SHMAL'KO, A. V.

[Abstract] Multimode interference of surface light waves was studied by a Mach-Zander interferometer consisting of optical microwaveguides with a dielectric stripline load. An analysis on the basis of analogy to integrated optics with negligible continuous part of the wave spectrum yields an added phase shift which increases monotonically to saturation as the effective refractive index increases, at a faster rate for a higher-order mode, and a modulation factor which varies as an oscillatory function of the phase difference between interfering modes of same order. The swing of the modulation factor decreases somewhat but its maximum value does not decrease much as the number of modes in the interferometer increases, because then the absolute values of their derivatives become larger with smaller difference between them. The authors thank V. A. Voznesenskiy and V. N. Pilipenko for assistance. Figures 4; references 13: 3 Russian, 10 Western (1 in translation).
[91-2415]

AZIMUTH DEVIATION OF SHORT RADIO WAVES ON MERIODINAL EXTENDED TRACES

MANAYENKOVA, N. I. and TSEDILINA, Ye. Ye., Institute of Terrestial Magnetism, Ionosphere and Propagation of Radio Waves, USSR Academy of Sciences

[Abstract] This work studies the azimuth deviations of short radio waves on extended (including around-the-world) meriodinal traces. The following items

are considered: 1) Azimuth deviation of angle of arrival; 2) Calculation of azimuth deviation of ray slipping along extended meriodinal traces; 3) Azimuthal deviation; and 4) Antipode displacement. A diurnal variation of azimuth deviations is found for different receiving points on the around-the-world meriodinal traces. Calculations are made for a shift and flattening of the focal "point" in the antipode. At present it does not appear possible to compare the results of calculations with experimental measurements of the azimuth deviations on extended meriodinal traces in connection with the absence of such data in the literature. At the same time it is possible to show that sharp horizontal gradients of a concentration of electrons in the polar regions of a real ionosphere, not considered in models of the ionosphere constructed for calm levels, can produce a substantial effect on the azimuth deviations on extended meriodinal traces. However, as shown in the literature, calculations made on the basis of a model of the ionosphere by the adiabatic method using extended traces including the polar ionosphere have a high precision. The authors thank V. V. Vas'kov and A. V. Gurevich for discussion of the work and for valuable comments, and G. M. Smirnov for assistance in computer calculations and processing of the results. Figures 4; references 21: 13 Russian, 8 Western.
[29-6415]

RADIATION CHARACTERISTICS OF LONGITUDINAL SLOT RADIATORS

GOROBETS, N. N. and LYASHCHENKO, V. A.

[Abstract] Three characteristics of a slot radiator, namely its radiation pattern, direction gain and power gain, have been calculated for a narrow slot of arbitrary length. The electric field in the slot was represented as a Fourier series of space harmonics and an infinitely large shield was assumed to adjoin the waveguide. Computer data obtained for wavelengths λ = 2.4, 3.2, 4.1 cm and various ratios of slot length L to wavelength λ agree closely with experimental data obtained with L/λ = 1. The results should be useful for the design of multielement antenna arrays. Figures 4; references: 2 Russian.
[91-2415]

POLARIZATION STATISTICS OF OBLIQUE PROBING SIGNALS IN APERTURE OF LINEAR
ANTENNA ARRAY

NOVOZHILOV, V. I.

[Abstract] Measurements of the polarization pattern of decameter-wave signals
in the aperture of linear antenna arrays for oblique probing of the ionosphere
at middle latitudes have been made since 1977. As a result, statistical data
have been accumulated which reveal the trend of the space correlation function
for fluctuations of the inclination angle of the polarization ellipse (its
major axis) at frequencies ranging from 9.7 to 18.8 MHz, the correlation coef-
ficient decreasing from 1.0 at zero distance to 0 at a distance of about 100 m.
Histograms of the difference between inclination angles and of its mean-square
fluctuations, referred to a measurement base of 120 m, indicate an appreciably
nonuniform polarization pattern of signals propagating through the ionosphere,
attributable to a shifting of their interference pattern. Figures 2;
references 3: 2 Russian, 1 Western.
[91-2415]

RESOLVING POWER OF RADAR STATIONS WITH ANTENNA ARRAYS

KREMER, I. Ya.; PON'KIN, V. A. and ROMANOV, A. D.

[Abstract] The resolving power of radar stations with antenna arrays for
continuous simultaneous tracking of all targets by simultaneous probing of
space and holographic processing of reflected signals can be increased by
widening the spectrum of the probing signal. The principle of this method
is based on the known dependence of the complex amplitude of the electric
field $\vec{E}(r,t)$ at a point $r_2 = \{x_2,y_2\}$ of the receiver antenna on the scattering
function of the target $f(\xi)$ and on the location $r_1 = \{x_1,y_1\}$ of the radiator
in the far zone of space. It is demonstrated on a linear antenna array whose
two extreme elements at both ends emit mutually orthogonal signals with com-
plex amplitudes and whose all elements receive the signals reflected by a
point target. The expressions for the intensity of the holographically re-
constructed image reveal that the major lobe in this case is half as wide and,
consequently, the resolution is twice as high as in the case of only one
radiating element at the center of the array. Figures 1; references 7:
6 Russian, 1 Western in translation.
[91-2415]

9

RADIO ASTRONOMY USING SUPERLONG BASE RADIO INTERFEROMETERS WITH SYNCHRONIZED TIME SCALES

ALEKSEYEV, V. A. and ANTONETS, M. A., Scientific-Research Institute of Radio Physics

[Abstract] The paper examines the use in radio astronomy of superlong base radio interferometers (RISB), and considers methods of determining the coordinates of cosmic radio sources, as well as the parameters of earth chords in their systems. It is shown that use of RISB with synchronized time scales make it possible to obtain both dynamic and geometrical solutions of radio astronomical problems and that these systems are simpler than in the case of use of RISB with systems of independent reception. This makes it possible to attain great precision. In addition to this, RISB-complexes which contain an earth satellite in its structure can operate in a real time scale. By and large this gives a reason to depend on the high efficiency of the use of such RISB for solution of radio astronomical problems and their applications. References 8: 7 Russian, 1 Western.
[29-6415]

SHAPING CHARACTERISTICS OF ZONAL FRESNEL LENSES IN MILLIMETER-WAVE RANGE

ANDREYEV, G. A., BAZARSKIY, O. V., KOLESNIKOV, A. I. and KHLYAVICH, Ya. L.

[Abstract] The characteristics of zonal Fresnel lenses which, in addition to light weight and small heat loss, make these devices suitable for shaping space spectra and radio images are analyzed in the millimeter-wave range. In an experiment, a ten-zone Fresnel lens made of acrylic glass with a 400 mm aperture and a 500 mm focal length with a frequency 75 GHz was used for producing radio images. The equipment also included a 40-80 GHz oscillator, a horn antenna, a corrective lens, a scanning antenna, a tuned amplifier and a photographic recording instrument. The performance of this lens was tested in paraxial and nonparaxial configurations. An important consideration is the performance of such a lens in a nonparaxial configuration with the object off the optical axis of the antenna. The pulse response in this case is evaluated in a Fresnel approximation with third-order aberration and paraxial aberration taken into account. Using the Rayleigh criterion for phase leads, the angular field of vision is calculated as a function of the relative distance from the object. Figures 5; references 5: 4 Russian, 1 Western in translation.
[91-2415]

RELATION BETWEEN POWER GAIN AND DIRECTIVE GAIN OF PHASED ANTENNA ARRAYS WITH
SPREAD OF PARAMETER VALUES

ZAYTSEV, E. F. and BABENKO, A. I.

[Abstract] The ratio of power gain G to directive gain D of phased antenna
arrays characterizes the efficiency of passive antennas and "internal" ampli-
fication in active antennas, as well as the receiver sensitivity when referred
to the aperture of equivalent noise temperature or to the noise factor. Here
this ratio G/D is evaluated for an array with spread values of channel
parameters. A wave of unit power is assumed to appear at the input. All
intermediate devices (mixers, filters, amplifiers, distributor) are matched
and decoupled at their outputs so that this ratio becomes equal to the ratio
of output power to input power and independent of the direction to the point
where measured. The feeders are generally mismatched at both ends so that the
equations describing incident and reflected waves include the scattering
matrix. On this basis, the ratio G/D is evaluated taking into account the
effect of random deviations of parameters. Random errors are first disregarded
and then also taken into account, as is reflection and coupling between radiator
elements. Calculations made in the approximation of a large array, i.e.,
of exciting radio pulses with linear phase lead reveal that phasing errors
reduce the output power and thus also the efficiency of or "internal" amplifi-
cation in active arrays. Figures 2; references 9: 7 Russian, 2 Western
(1 in translation).
[91-2415]

ANALYSIS OF MODEL EXPERIMENTS AND CALCULATIONS OF CORNER-REFLECTOR ANTENNA
FOR SUBMILLIMETER MIXER

KRAYEV, N. P. and STRUKOV, I. A., Institute of Cosmic Investigations,
USSR Academy of Sciences

[Abstract] This brief communication analyzes the directivity characteristics
of the corner-reflector antenna of a submillimeter wavelength mixer with a
short-circuit at the end of the Γ-shaped contact wire of a diode, taking
account of the radiation of all its parts. The results are presented of a
calculation of the input impedance of the antenna, which are compared with
data from measurements of antenna models in the 3-centimeter range. The
models were 90° corner reflectors. Figures 1; tables 1; references 10:
3 Russian, 7 Western.
[29-6415]

UDC 621.314.1

OPTIMUM CHARGING OF CAPACITIVE STORAGE DEVICE FROM DC LINE VIA CONVERTER

DOROSHENKO, B. I., KIREYEV, S. P. and OKOROKOV, A. A., Kharkov Aviation
Institute

[Abstract] An analysis is made of charging circuits that use intermediate
DC-to-AC voltage converters to charge capacitive storage devices to voltages
considerably higher than the potential of the available DC supply line.
By using an inductance in such circuits with time constant longer than the
half-period of operation of the converter, the rectified voltage is controlled
by changing the duration of the pulses taken from the source of electric
energy, i.e. by pulse-duration modulation in the converter. Two versions of
such charging devices are considered in which the inductances are in the
alternating or rectified current circuits. In the first the inductance is
provided by step-up transformer windings, and in the second by a choke in the
rectified current circuit. A varional calculus technique is used to find the
optimum laws of current regulation which minimize losses in the circuits at
predetermined values of the storage capacitance and charging time. Figures 2;
references: 2 Russian.
[34-6610]

UDC 621.314.572

HIGH-POTENTIAL ELECTRONIC VOLTAGE CONVERTER

KOCHKIN, V. I., OBYAZUYEV, A. P. and TOLSTOV, Yu. G., MONIIPT [Moscow Branch
of the Scientific Research Institute of Direct Current]

[Abstract] The authors analyze the electromagnetic processes in a voltage
converter with completely controllable electronic diodes capable of rectification

and inversion without taking reactive power from the AC line. The operational characteristics of the converter are considered with regard to the working conditions of the diodes and their effect on the quality of the converted energy. Expressions are derived for determining the parameters of the converter from predetermined operating conditions and coefficient of harmonics of the phase current, and for determining working conditions from known parameters. It is shown that the harmonics of the phase current do not influence the average input current. An expression is given for finding the amplitudes of the sine and cosine components of harmonics of the input current. Examples are given of calculation of some converter characteristics under operating conditions with consumption of reactive power and generation of reactive power. Figures 5; tables 1; references: 5 Russian.
[34-6610]

WALSH SPECTRUM OF FREQUENCY CONVERTER WITH DIRECT COUPLING

TSAGARAYEVA, F. O., Northern Caucasus Mining and Metallurgical Institute

[Abstract] A comparative analysis is made of the effectiveness of using trigonometric functions and Walsh functions as a basis for approximating electromagnetic processes in frequency converters with direct coupling and natural commutation. It is assumed in the analysis that commutation of diodes is instantaneous, and that currents across the output of the frequency converter are maximally continuous. The preferable system of approximating functions is selected by expanding the commutated emf's in a series with respect to orthogonal Walsh and Fourier functions, where the period of the expansion is equal to that of the controlling signal. The number of approximating functions z was determined by the passband of the system, the frequency band of the system being broken down into z values of the control signal frequency. The results show that Walsh functions should be given preference for studying the dynamics of such converters. Figures 3; references: 5 Russian.
[34-6610]

OPTIMIZATION OF INPUT SIGNAL TO LINEAR FILTER FOR MAXIMUM SIGNAL-TO-NOISE RATIO

POLYAK, B. I.

[Abstract] The optimum input signal with additive correlational noise is determined for a linear filter, taking into account constraints on signal duration and filter bandwidth. Maximum signal-to-noise ratio is used as the optimality criterion and the noise is assumed to be Gaussian with known energy spectrum. The filter is represented as a combination of two four-pole networks in series, the first one converting the correlational input noise to "white" noise and the second one restoring the transfer function of the filter. The maximum attainable output signal-to-noise ratio is calculated on this basis. The transfer function of the complementary second four-pole network and the spectrum of the optimum output signal are found to depend only on the energy spectrum of the input noise and on the spheroidal wave functions which satisfy the integral equation describing the optimum finite-duration input signal for given values of parameter $c = 1/2\omega_m T$ (ω_m - filter cutoff frequency, T - signal period). For comparative estimates is also calculated the optimum signal-to-noise ratio attainable with three different nonoptimum signals (exponential, rectangular, Gaussian), and an $N_1(\omega) = N_0\omega_N^2/(\omega_N^2 + \omega^2)$ noise spectrum, the signal having either the same effective duration of the same spectral width as the optimum signal. The optimum signal improves the signal-to-noise ratio by an amount which increases as the product of signal duration by filter bandwidth decreases. Figures 3; references 6: 5 Russian, 1 Western.
[91-2415]

COMMUNICATIONS

CONTINUOUS ASYMPTOTICS OF SOLUTIONS IN THE CASE OF LINEAR INTERACTION OF
WAVES IN ABSENCE OF POLARIZED DEGENERATION

YASHIN, Yu. Ya. and YASHNOV, V. A., Gorkiy State University

[Abstract] This paper considers a linear transformation of normal waves in
3-dimensional media. A system of coupled equations for the amplitudes of
interacting waves is obtained. A first integral is written on the basis of
this system. The integral has the sense of the law of conservation of the
total energy flux of the interacting waves. Criteria determining the degree
of connectedness of the waves are obtained. The radius of interaction within
which a noticeable transformation of energy from one wave to another takes
place is also found. Only the case of strong interaction is considered.
This is when the parameters characterizing the magnitude of the effect of
interaction are large or on the order of $(KL)^{-1} \cdot$ ($K = 2\pi/\lambda$, λ = length of the
wave, L = characteristic measure of the nonuniformity of the medium). Such
interaction takes place in the neighborhood of the point of synchronism. It
is assumed that a finite number of synchronism points exists along the original
ray. Problems are solved concerning the interaction of normal waves in a
medium. The properties of the medium change in accordance with the cosine
law. Similar problems are also considered mathematically. These problems,
particularly nonlinear problems, are described by analogous systems of equa-
tions. In these cases a solution is constructed on the basis of a number of
perturbation theories. The radius of interaction is determined. The authors
thank N. S. Bellyustin, N. G. Denisov, S. Ya. Vyshkind and Yu. A. Kravtsov
for dis ussion of various sections of the work and for a number of helpful
comments. Figures 2; references 24: 18 Russian, 6 Western (1 in translation).
[29-6415]

MODELING DISCONTINUOUS FUNCTION IN ELEMENTAL BASIS OF AMPLITUDE SELECTORS

VOLGIN, LEONID IVANOVICH, doctor of technical sciences, professor,
Ul'yanovsk Polytechnic Institute

[Abstract] An adequate basis of logic functions for selection of the largest
and smallest of two signals x_1 and x_2 is proposed, namely

$$y = \max(x_1, x_2) = 0.5(x_1 + x_2 + |x_1 - x_2|)$$

$$y = \min(x_1, x_2) = 0.5(x_1 + x_2 - |x_1 - x_2|)$$

naturally duplicating any elementary discontinuous function (mod, sign,
lim, $\int$, ext). It also provides a convenient tool for synthesis and analysis
of electric circuits with nonlinear control and regulation algorithms modeling
such functions, namely amplitude selectors in the form of analog logic elements
with transformation function $y = \text{ext}(x_1, x_2 \ldots, x_n)$. The applicability of this
selection basis to all standard discontinuous functions as well as several
nonlinear and logical signal transformations is demonstrated on four types of
amplitude selectors also constituting unilateral parallel limiters with ad-
justable limiting: maximizing, minimizing, maximizing with one inverting
input, maximizing with one inverting input and a doubling inverting output.
Its applications are further demonstrated on two different amplitude selec-
tors in series, a "pedestal", a median extractor, and a threshold surpassor.
Open-loop amplitude selectors can be built with passive or active elements,
closed-loop amplitude selectors with feedback require active elements with
characteristics of controllable voltage sources. Figures 9; references:
10 Russian.
[62-2415]

ADEQUACY OF DIGITAL MODEL OF PHASE-TYPE AUTOMATIC FREQUENCY CONTROL

RUSSKIKH, N. P.

[Abstract] The prevalent digital model of phase-type automatic frequency
control is considered, where the phase detector subtracts the total phase of
the reference signal from the total phase of the signal from the controlled

oscillator and then calculates the sine of their phase difference. The model also includes a filter, an amplifier behind the phase detector, and an element which produces a phase delay per cycle equal to the discretization step for the oscillator. Considering the fact that analog components have been replaced with digital equivalents and the phase delay is fictitious, it is necessary to test this model for adequacy prior to its use for design and performance analysis through simulation. This is done here with stability of the system "in the large" and "on the whole" in the absence of noise serving as adequacy criterion. On this basis, the transient processes are found to be identical in two analytically describable variants of a phase-type automatic frequency control system and in this model of such a system: 1) system without filter and 2) system with proportional integrating filter (m = 0.4). Numerical experiments indicate that the simulation error caused by introduction of the phase delay becomes negligible when $\omega_h T \leq 0.1$ ($\omega_h = 2_\pi \Delta f_h$, Δf_h- frequency holding band, T- discretization step). The frequency locking band will then also be adequately simulated. Figures 3; references: 2 Russian.
[91-2415]

UDC 621.391.037.372:621.325.658

ADAPTIVE DIGITAL METHODS OF SIGNAL PROCESSING

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 10, Oct 82 (manuscript received 2 Feb 81) pp 1916-1922

ABRAMOVICH, Yu. I., KRYUCHKOV, V. V., MIKHAYLYUKOV, V. N. and SARYCHEV, V. A.

[Abstract] Digital communication channels with protective compensating channels are considered, and the (N-1)-dimensional vector of signal processing which will ensure minimum interference output power is synthesized by two adaptive methods. The conventional method maximizes the signal-to-interference ratio while minimizing the mean-square error and is based on a representation of the Wiener-Hopf solution which makes it possible to directly estimate, on the basis of the correlational interference matrix and with the aid of the appropriate recurrence relation, the dependence of the interference suppression efficiency on the volume of the learning sample. The other method is based on Gramme-Schmidt iteration and orthogonalization, which in the case of finite-length arithmetic leads to solutions with different properties. The latter makes this method most preferable where the number of simultaneously processed channels must be minimized, while the conventional method remains preferable where the number of channels must be increased until a quasi-isotropic radiation pattern is obtained. Figures 9; references 10: 4 Russian, 6 Western (3 in translation).
[91-2415]

ALGORITHMS OF SPACE-TIME PROCESSING OF SIGNALS WITH INTERFERENCE

PON'KIN, V. A.

[Abstract] The signal-to-noise ratio at the output of systems for optimal
processing and matched processing of signals with interference from an
external source is estimated by an approximate method which uses measurement
errors in locating a target through optimal processing of signals without
interference. Calculations are based on arbitrary locations of target and
interference source relative to the receiver antenna. The correlation func-
tion is evaluated approximately, with the aid of Taylor series expansion and
replacement of its first two terms with an exponential one. The error of
this method is evaluated through comparison with exact calculations for a
linear antenna with uniform aperture function and narrow-band space-time
processing of signals. Both methods are then used for calculating the
energy utilization factor in the case of optimal processing and in the case
of matched processing, with the target in the far zone and with the inter-
ference source in the Fresnel zone of the receiver antenna. Figures 2;
references: 5 Russian.
[91-2415]

DEVELOPMENT OF METHOD OF NONORTHOGONAL SERIES AND INVESTIGATION OF PROBLEM
OF DIFFRACTION BY DIELECTRIC BODIES

SVESHNIKOV, A. G. and YEREMIN, Yu. A., Moscow State University

[Abstract] This brief communication is concerned with a farther development
of the method for solution of the problem of diffraction by a dielectric
body of revolution which is presented in a 1980 report by A. G. Sveshnikov
and Yu. A. Yeremin (see above). It is concluded that the numerical algorithm
developed is effective and that the simplicity and reliability of the compu-
tation scheme of the method, as well as the presence of the interior criteria
for evaluation of the quality of the approximate solution obtained make it
possible to vary the parameters of the geometry of the scatterer and the nature
of the filling medium. In problems of optimization of the geometry of the
form of the scatterer or interior filling (ε, μ), the algorithm developed can
also be used for the purpose of realization of the specified energy nature
of the scattered field in the wave zone. Figures 3; references 6: 5 Russian,
1 Western in translation.
[29-6415]

ABSORPTION CURRENT IN PLANE-PARALLEL PIECEWISE INHOMOGENEOUS INSULATION

IYERUSALIMOV, M. Ye., IL'YENKO, O. S., ABRAMOV, V. B. and VASILENKO, N. V.,
Kiev Polytechnical Institute

[Abstract] In a previous paper by Iyerusalimov and Il'yenko [see
ELEKTRICHESTVO, No 10, 1980 pp 36-41], a mathematical model of absorption

processes in isotropic media was considered in which absorption current i_a was expressed in terms of the free component $\vec{E}_{CB}$ of electric field strength in insulation because of redistribution of charges in the volume of the dielectric:

$$i_a = \int_{S_\mathfrak{z}} (\sigma\vec{E}_{CB} + \varepsilon\frac{\partial\vec{E}_{CB}}{\partial t})d\vec{S}. \qquad (1)$$

Here σ and ε are the volumetric conductivity and permittivity of the medium, and $S_\mathfrak{z}$ is the electrode area. The process of spatial and temporal behavior of electrical field strength in inhomogeneous isotropic insulation is defined by the differential equation

$$\frac{\partial}{\partial t}\text{div}(\varepsilon\vec{E}) + \frac{\sigma}{\varepsilon}\text{div}(\varepsilon\vec{E}) + \vec{E}(\text{grad }\sigma - \frac{\sigma}{\varepsilon}\text{ grad }\varepsilon) = 0, \qquad (2)$$

where

$$\vec{E} = \vec{E}_{CB} + \vec{E}_y, \qquad (3)$$

($\vec{E}_y$ is the field strength in the steady state). In the general case, solution of (2) is complicated as it is not represented in elementary functions. However, in most cases of practical importance, high-voltage insulation can be represented as a piecewise-homogeneous medium in which the interfaces between homogeneous regions are parallel planes. Using this approximation, the authors simplify the solution of (2) and determine absorption current. It is shown that absorption currents in multilayered insulation are equal in magnitude but opposite in sign with carging and discharging. Figures 1; references: 4 Russian.
[34-6610]

UDC 621.396.677.494.71.001.1

EXTERNAL NATURAL AND MUTUAL CONDUCTANCES OF SLOTS IN INFINITE PLANE SHIELD COVERED BY DIELECTRIC LAYER

BODROV, V. V. and GRIDNEV, V. I., Moscow Power Engineering Institute

[Abstract] This work describes a means for calculation of the mutual and natural conductances of slot emitters, located under a dielectric layer. Examples are presented which show the necessity for consideration of the effect of the dielectric layer on the parameters indicated. It is noted that the necessity in such a means is caused by the fact that the mutual conductances with respect to various basic functions are an intermediate parameter for calculation of all the technical characteristics of a slot antenna array. The calculation is accomplished by taking into account the mutual effect, both with respect to the interior and the exterior space

wave guide of the slot antenna. In the calculation, the distribution of the electrical field across the slot is described by the function $\psi(X_r')$. This function is either a constant or it takes into account the special features of the field close to the edge of the shield. It is shown that the form of the function $\psi(X_r')$ weakly affects the amount of the conductivity, especially in the resonant region. Graphs are shown of the natural conductance for various dimensions of the slots and the parameters of the dielectric layer. In addition, graphs are shown of the mutual conductances of two slots for two forms of bias. Figures 9; references 9: 7 Russian, 2 Western. [29-6415]

ELECTRON DEVICES

PECULIARITIES OF CONTINUOUS OPERATION OF GUNN-EFFECT DIODE

KHUCHUA, N. P., SHOYKHET, L. Kh., GUTNIK, L. M. and MAMATSASHVILI, N. N.

[Abstract] The equation of steady-state heat conduction for the "sandwich"
model of a Gunn-effect diode with its active region mounted directly on a
massive heat sink yields anomalously high hot-spot temperatures at the
upper boundary of the active region during constant-bias operation when the
active region is mounted on the heat sink through a thin n^+-GaAs sublayer,
a metal contact, and a conducting adhesive interlayer. In order to explain
this, the equation of heat conduction has been modified so as not to dis-
regard convective heat transfer from active region to ambient medium even
when the thickness of the n^+-GaAs sublayer (40-50 µm) by far exceeds the
length of the active region (10 µm), as in many practical situations.
Temperatures calculated on this basis agree more closely with those obtained
experimentally by the method of liquid crystals. The difference between
hot-spot temperature and cathode temperature is found to depend less on the
"cold" resistance as the thermal conductivity of the interlayer decreases
or as the thickness of the sublayer increases. Figures 2; references 8:
2 Russian, 6 Western.
[91-2415]

DESIGN OF ELECTROOPTIC DIFFRACTION DEFLECTOR TAKING INTO ACCOUNT EDGE EFFECTS

DIANOVA, V. A., MUSTEL', Ye. R., SVESHNIKOV, A. G. and SHAPKINA, N. Ye.

[Abstract] A deflection system with a "brilliant" phase grating induced in
an anisotropic electrooptic crystal is considered for switching light from

one diffraction peak to another. The longitudinal profile of the phase delay and dependence of the latter on the electric field distribution as well as on the light intensity distribution are calculated from the Laplace equation and the diffraction law, with edge effects at the electrode surfaces taken into account. The corresponding Riemann-Hilbert problem with appropriate boundary conditions is reduced to an infinite system of linear algebraic equations of the Ax = b kind with elements of the A-matrix in the form of Legendre polynomials. A numerical solution based on a 21 x 21 matrix has been obtained, with the aid of a BESM-6 computer, for an $LiNbO_3$ crystal with an electric field parallel to the optical axis. A deflector grating has been designed on this basis for light at the $\lambda = 0.63$ μm wavelength with transverse polarization. Its performance is compared with that of an ideal deflector capable of 100% switching. The results are also compared with experimental data. Figures 5; tables 2; references 5: 3 Russian, 2 Western. [91-2415]

DEVICE FOR MEASURING SPEED OF SOUND ON CONTINUOUS WAVEFORMS WITH FEEDBACK

STEFANOV, S. R. and CHISTOSERDOV, Yu. P.

[Abstract] The authors have developed a device for measuring the speed of sound in which the circuit for emission and reception of acoustic waveforms with positive feedback permits realization of a simple form of the phase method of measurement with frequency output. By introducing the feedback between the receiver and emitter via an amplifier, the sensitivity of the device is made independent of the measurement base when the number of acoustic wavelengths between emitter and receiver is much greater than $\phi/2\pi$ (ϕ is parasitic phase advance in electric circuits). A peculiarity of operation of the device is that the length of a sound wave in the medium remains constant: the oscillation frequency automatically varies when measuring the speed of sound. Another advantage of the device is high stability caused by the fact that phase lead in the electric circuits generally does not exceed 2π, so that when the number of acoustic wavelengths between emitter and receiver is much greater than $\phi/2\pi$ the frequency stability is weakly dependent on the measurement base and may reach 10^{-6}-10^{-7}. Disadvantages are the necessity for stand calibration and limited measurement range. It is proposed that circuits with extra receivers be used to overcome these advantages. A two-receiver arrangement has static response with 100 times the slope of the sing-around system. Figures 3; references: 3 Russian.
[33-6610]

MICROWAVE WIDE-BAND STRIPLINE AMPLIPHASE METER

BESPALOV, V. B. and ASLAMAZYAN, A. S.

[Abstract] The authors describe the working principles of a microwave ampliphase meter in which the reference signal and the phase-modulated signal to be measured are sent to the inputs of a ring power divider. The reference signal is equally divided and sent through two channels without phase shift to balanced mixers that act as phase-sensitive components. The signal to be measured is equally divided with a phase shift between halves of 90°, and sent to the second inputs of the same mixers. The resultant currents at the mixer outputs are porportional to the sine and cosine of the relative phase of the signal being measured and its amplitude. A printed-circuit stripline version of this device is proposed. By using a circuit board of foil-covered Teflon 1.5 mm thick with wave impedance of the channel of 50 ohms, admissible nonuniformity of transient attenuation of 0.2 dB in a relative frequency band of 57%, the stripline with wave impedance of 50 ohms will have a width of 2.52 mm. In the coupling region, the stripline will be 0.96 mm wide with a gap of 0.05 mm and length equal to $1/4\lambda$ on the central frequency. For ampliphase meter error of less than 2°, the VSWRs of the individual components and input should not exceed 1.35 with VSWR of the device to be tested of at least 1.1. Tests of the proposed device in a relative frequency band of 54.5% at power of no more than 10 mW in the reference channel showed rms phase error of 1.5°, relative error of amplitude measurement in a dynamic range of 0-20 dB of no more than 0.6 dB, and sensitivity of 10^{-10} W. Figures 2; references 8: 7 Russian, 1 Western.
[33-6610]

AUTOMATING OSCILLOSCOPIC FREQUENCY DEVIATION MEASUREMENT METHOD

ITSIKSON, A. I. and OBUKHOVA, L. N.

[Abstract] The authors suggest a modification of the oscilloscopic method of measuring frequency deviation which can be automated. At the difference frequency between the carrier and heterodyne frequencies, a quasi-horizontal section appears on the oscilloscope, and the voltage is $u_p = U_m \sin \pi\beta$, where β is the ratio of the difference frequency to the modulating frequency. For all but whole-number values of β the voltage is non-zero and depends on β. Signal and modulating frequency requirements are determined for specific radio applications, and a block diagram is given of a device which realizes the proposed method. Figures 1; references: 6 Russian.
[33-6610]

MEASUREMENT OF SPECTRUM OF PULSE-MODULATED SIGNAL PHASE FLUCTUATIONS BY
FREQUENCY DETECTION METHOD

KASHIRIN, V. N.

[Abstract] An examination is made of the spectrum of voltage components in
the case of frequency detection of a pulse-modulated signal, and the relation
between this spectrum and the continuous spectrum of phase fluctuations.
The analysis is based on a typical circuit for measurement of frequency
fluctuations with suppression of the carrier, including a modulator,
attenuators, phase shifters, a balanced bridge, a resonator, a double wave-
guide tee, a shorting device, microwave phase detector, and a filter that
isolates the frequency band to be investigated. The energy signal spectrum
is found in terms of the noise power at the output of the phase detector.
It is shown that measurement of the spectrum of phase fluctuations of a
pulse-modulated signal necessitates preliminary analysis of the shape of
the spectrum of the low-frequency signal in the corresponding frequency
range, as well as analysis of the amplitude spectrum of the modulation
pulses. The proposed circuit is suitable for measurements except where the
spectrum of fluctuations of low-frequency signal phase at the modulator
input falls no more slowly than the reciprocal of the square of the frequency
band being analyzed. Figures 2; references: 3 Russian.
[33-6610]

PRECISION WATTMETER FOR PULSED MICROWAVE POWER

MYL'NIKOV, A. V.

[Abstract] A pulse wattmeter is described which gives high measurement
accuracy and can be calibrated without using laboratory pulse power measure-
ment equipment. The device is based on an energy comparison method: the
total energy of the measured pulse $W = \int_0^T P(\gamma)d\gamma$ (T is the pulse recurrence
rate) is compared with the energy on a known time interval. The pulse
power is then found as the ratio of energy to the duration of this inter-
val. Peak power, or power on any pulse segment can be measured by this
method, using appropriate selection of the time interval, which is a com-
plete analog of sampling. A block diagram is given of a device for realizing
this method, containing an integrating bolometric converter, an average power

readout unit, an amplifier with two opposed-phase outputs, a cutout with delay line, an adder, pulse voltmeter and frequency meter. The error of such an instrument is 2.5-5%, and is determined mainly by the error of measuring average power. Figures 3; references: 5 Russian.
[33-6610]

CONTROL OF SEMICONDUCTOR-TYPE POWER SWITCHES BY MEANS OF MICROWAVE RADIATION

GREKHOV, I. V., KARDO-SYSOYEV, A. F. and KRIKLENKO, A. V., Physico-Technical
Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] Fast switching of heavy power by means of dynistors is analyzed,
charge carriers being generated by impact ionization in a field of strong
microwave radiation. A p-n structure is considered with the dopant acceptor
concentration much higher than the donor concentration in the p-region and
with a constant voltage applied to the metallic contact tabs driving the
p-n diode toward cutoff. The electric field distribution and the thermal
losses in the entire structure, including the space-charge region, are cal-
culated from the Maxwell equations with appropriate boundary conditions.
Both electrodes are assumed to be lossless, with infinitely high electrical
conductivity. All field components are assumed to be functions of the normal
y-coordinate and thus to represent a lowest-order mode. At subthreshold
field intensities the carrier concentration in the space-charge region is
determined by the leakage current from the p-n junction and is negligible
under real conditions. The frequency of the field is sufficiently high to
make any change in the thicknesses of the p-region and the n-region because
of displacement of the space-charge-region boundary in one half-period
negligible. The structure is inserted into a waveguide with a microwave
oscillator at one end. Propagation of an electromagnetic wave through this
waveguide and its attenuation due to power absorption are calculated, taking
into account wall losses. A practical case of exciting a "symmetric" electro-
magnetic field by means of two identical oscillators, one at each end of the
waveguide, and two corresponding transmission lines is also evaluated.
Figures 2; references: 3 Russian.
[67-2415]

CORRUGATED CYLINDRICAL RESONATORS FOR SHORT-WAVE RELATIVISTIC MICROWAVE GENERATORS

DENISOV, G. G. and REZNIKOV, M. G., Institute of Applied Physics, USSR Academy of Sciences

[Abstract] The results are presented of theoretical and experimental investigations of corrugated resonators for relativistic electron generators based on a multimode waveguide of circular cross section with periodic and quasi-periodic corrugations. Part of the results of this work was reported at the 9th All-Union Conference on Microwave Electronics (Kiev, 1979). Conditions and equations of selective interaction of two waves, and coupling coefficients are considered. An experimental investigation was made of several resonators based on a multimode axisymmetric waveguide with rectangular corrugations. The investigation was conducted in the range of 10 mm and 4.0-5.0 mm. The scheme is presented of an arrangement for measurement of resonance frequencies and the Q of oscillations. It is shown that operation of the resonators is based on the effect of the phasing selective reflective of a waveguide wave from periodic inhomogeneities. The authors thank S. N. Vlasov and M. I. Petelin for attention to the work and for helpful council. Figures 6; tables 1; references 14: 9 Russian, 5 Western.
[29-6415]

POWER ENGINEERING

EFFECTIVENESS OF PROTECTIVE SHUNTING OF PERSON WHO HAS TOUCHED LIVE PHASE

GLOVATSKIY, G. G., docent, Order of Lenin L'vov Polytechnic Institute imeni Lenin Komsomol

[Abstract] High-speed phase grounding devices are installed in 3-10 kV electric power networks for protection of a person who has touched a live phase. The development these devices follows an extensive study of the effect of transient low-frequency (50 Hz) current on the human body, both magnitude and duration of the current having been found to determine whether or not fibrillation of the heart can be avoided. Here the performance and effectiveness of a phase grounding device are analyzed in relation to processes occurring after the shunting path has been closed. The resistance of a human body is assumed to remain within 600-1000 ohms independently of the voltage across it, above 1000 V as well as when the voltage drops below that level. On this basis, the voltage across a person to ground is calculated as a function of the distance from the protective device and of relevant circuit parameters. The design of such a device is considered next, namely calculation of its resistance. Its minimum resistance is determined by the substation grounding resistance (not higher than 0.5 ohm), its maximum resistance is determined by the maximum allowable voltage across a person (65 V), on the ratios of resistive and capacitive components of line and fault impedances, on the compensation mismatch factor, and on the capacitive current through the metallic phase grounding conductor. A worst-case design allows for a fault resistance of at least 1000 ohms and a fault location near the protective device. Article submitted by Department (Kafedra) of Electrical Systems and Networks. Figures 2; references: 2 Russian. [63-2415]

SYNTHESIS OF HIGH-VOLTAGE DISTRIBUTOR CIRCUITS

MYSLIN, D. A., candidate of technical sciences, Siberian branch, VGPNII (possibly All-Union State Design and Scientific Research Institute) "Energoset'proyekt" (All-Union State Planning Surveying and Scientific Research Institute of Powers Systems and Electric Power Networks)

[Abstract] The method of graphs is applied to synthesis of power distributing circuits from the standpoint of optimum tradeoff between flexibility, reliability, and economy. The constraints are defined accordingly, the number of necessary interconnections for a given number of power sources and a given number of power users being the major criterion. A tree, a graph characterized by the minimum number of branches for a given number of vertices, is considered more specifically. For any given number of vertices n there is only one configuration possible when $n \leq 3$ but several configurations are possible when $n > 3$ and the number of possible configurations increases fast as n becomes larger. Also various symmetries are considered, e.g., central symmetry leading to a star graph and translational symmetry leading to a chain graph. The effects of adding or removing circuit elements on network flexibility, reliability, and economy are analyzed in terms of adding or removing branches in both types of graph. Figures 2; references: 5 Russian.
[65-2415]

VOLTAGE REGULATION UNDER LOAD IN ELECTRICAL NETWORKS BY MEANS OF THYRISTOR-TYPE DEVICES

GUREVICH, V. I., engineer, and SAVCHENKO, P. I., candidate of technical sciences, docent, Kharkov Institute of Mechanization and Electrification of Agriculture

[Abstract] A comparative performance analysis of mechanical and thyristor-type under-load voltage regulators is made on the basis of normalized costs, according to the A. N. Mel'nikov method. The economic effect of changeover from smooth to stepwise regulation without waveform distortion is included in the analysis, taking into account the consequences of nonsinusoidality of the voltage waveform as far as operation of distribution and appliance transformers and of induction motors is concerned. Calculations, using

standard formulas for equipment operating cost factors, have been programmed in FORTRAN on a YeS-OS digital computer. Results indicate that the cost of using thyristor-type under-load regulators can reach levels which, depending on voltage and power rating as well as on the type of load, may yield a negative overall economic effect. Article submitted by faculty council. Figures 3; references: 4 Russian.
[65-2415]

DIGITAL PROCESSING OF LASER DOPPLER VELOCITY MEASURER SIGNALS WITH NONUNIFORM DISCRETIZATION

GAPONOV, V. A. and TOMSONS, Ya. Ya., Novosibirsk

[Abstract] Nonuniform discretization of the measured process is a charac-
teristic feature of optical instruments such as laser Doppler velocity
measurers (LDIS), one which affects the subsequent processing of signals
and thus also the choice of electronic equipment for this purpose. Here
are shown algorithms for estimating the integral characteristics of a random
input process, namely its sample mean and spectral density, on the basis of
stochastic discretization in some cases but not always into a Poisson dis-
tribution. These algorithms have been programmed, and were used in numerical
experiments with various sinusoidal test signals. A quadrinomial Blackman-
Harris window was used for discretization of these signals into Poisson dis-
tributions with $\lambda = 1$ or 0.25. Discretization into an exponential distribu-
tion was also tried. The procedure includes special "fitting" of the sequence
of readings to the discretization model. This procedure is particularly
useful when the mean intensity of the point process which determines the
instants of discretization depends on the amplitude of the measured process.
The "fitting" can be effected with appropriate hardware or appropiate
software. Its effectiveness is demonstrated by the example of a random
process discretized first periodically, then into a Poisson distribution, and
then into a distribution with the intensity linearly dependent on the ampli-
tude of the signal generated according to the more general model. Figures 5;
references 16: 11 Russian, 5 Western (1 in translation).
[61-2415]

ACOUSTOOPTICAL BEAM SPLITTERS IN TWO-COMPONENT LASER DOPPLER VELOCITY
MEASURER

ANTONOV, S. N., LITVINOV, V. M., PROKLOV, V. V., SKVORTSOV, V. V. and
FILATOV, A. N., Moscow

[Abstract] Acoustooptical cells for producing a frequency shift in laser
Doppler velocity measurer (LDIS) are designed to ensure minimum light losses
and thus accurate measurement with low laser power, and to ensure a suffi-
ciently large temperature-independent angular deviation of the diffracted
beam so that the latter can, after splitting, be separated from the non-
diffracted one without additional optics. A cell with Bragg diffraction is
most promising for this application, and dividing the intensity equally
between diffracted and nondiffracted beams makes it possible to combine
splitter and frequency modulator in the same element. An acoustooptical
cell has been precisely designed and manufactured on this basis, with a
paratellurite crystal serving as acoustic waveguide, a $(Y + 163°)$-cut $LiNbO_3$
crystal serving as converter of ultrasonic waves, and a TeO_2 crystal serving
as absorber. Adequate acoustic contact between these components is provided
by $C_9H_{11}O_2$ ether, crystalline in the solid state below 100°C, and optical
reflectivity of surfaces is reduced by SiO_2 coatings. Cells of this type
cover the 4.5-40 MHz frequency range and require only 0.1-0.3 W of power
for splitting a light beam into halves. A distinguishing feature of such a
cell is its ability to split two light beams simultaneously at different
wavelengths. A laser LDIS with such a cell was used experimentally for
measuring velocity components and fluctuation parameters of supersonic
streams. The authors thank professor G. L. Grodzovskiy for steady interest
and helpful discussions. Figures 3; references 7: 4 Russian, 3 Western.
[61-2415]

LASER DOPPLER VELOCITY MEASURER WITH LIGHT GUIDE

YEVSEYEV, A. R., Novosibirsk

[Abstract] Unlike conventional laser Doppler instruments, those with fiber
optics as light guides are capable of measuring velocities in optically
opaque media such as blood and in two-phase streams with high concentration
of solid or liquid particles in the gas or of solid or gaseous particles in
the liquid. Measurement is possible here with an optical fiber, or a bundle

of them, accommodated within a sufficiently small locality in the stream. Such an instrument operating with a single fiber and a reference light beam has been built for measuring the velocity of buoyant gas bubbles in a liquid and was tested on air bubbles in glycerin. It consists of a laser source, a mirror with a hole for passing the laser beam, an objective, and a 12 m long optical fiber (core diameter 50 μm, sheath diameter 150 μm, ends cut at right angles to the axis) from which at the other end immersed in the liquid emerges a convergent conical probing light beam. The wave reflected by the fiber wall at this end back into the fiber serves as reference beam, while light scattered by an approaching gas bubble also enters here. Both are transmitted through the fiber to the objective on the front side, which passes them through an aperture lens to a polaroid and from here through a focusing lens to a photoreceiver followed by a band-pass filter before an oscillograph, a spectrum analyzer, and a Doppler signal processor operating in parallel. In the experiment with air bubbles in glycerin an 8 mW LG-52-1 laser and an FD-10 KP photodiode with a 0.3 mm diaphragm yielding a signal-to-noise ratio of the order of 20 dB was used. Bubbles were generated by injection of air into the glycerin container at pressures up to 600 mm H_2O. For verification, measurements were also made with a conventional laser Doppler velometer in the differential mode. Both method of measurements have revealed a linear dependence of bubble velocity on gas pressure. The buoying velocity corresponds to the highest-frequency Doppler signal and pricking a bubble slows it down. Figures 3; references 5: 2 Russian, 3 Western.
[61-2415]

LASER DOPPLER ANEMOMETRY WITH SELECTION OF COHERENT COMPONENT IN OPTICAL SIGNAL

DUBNISHCHEV, Yu. N., ZHURAVEL', F. A. and PAVLOV, V. A., Novosibirsk

[Abstract] The optical signal appearing in a laser Doppler anemometer is analyzed after passage through a medium with high concentration of scattering particles. Such a signal consists of a coherent component and a "noncoherent" one with overlapping frequency spectra. The probing field of Gaussian beams is assumed to cross a homogeneous stream of scattering point particles. The possibility of extracting the coherent component, the one contained within a narrow band relative to the carrier frequency, is considered in a differential scheme with interference of incoming beams and with the aid of a selective filter. Such a device consists of a laser with a beam shaper containing a frequency shifter, a space where the light beams form the probing interference field with fringes moving at a known constant velocity, and an objective preceded by an aperture stop and followed by a 45° beam splitter. One part of the beam passes through the splitter into the incoherent

channel, namely to a second objective and from here to a photoreceiver.
The other part of the light beam is reflected by the splitter into the co-
herent channel, where it passes through an even space-frequency filter in
the Fourier plane of the first objective to a photoreceiver. The filter
is matched to the concentration of scattering particles and the parameters
of the measurement region in the Fourier plane of the first objective. The
performance of this device is demonstrated on a one-dimensional Poisson
beam of scattering particles moving at constant velocity. The statistical
mutual independence of phase noise in each component can beuutilized for
improving the accuracy of measurements with correlational laser Doppler
anemometers, the cross-correlation function for the two frequency-demodulated
components being obtainable with suppressed phase noise in each and coinciding
with the autocorrelation function for the analyzed process. Figures 3;
references 5: 3 Russian, 2 Western.
[61-2415]

DEVELOPMENT OF LASER DOPPLER AND STROBOSCOPIC ANEMOMETERS FOR STUDY OF FAST
PROCESSES

ALKHIMOV, A. P., BOYKO, V. M. and PAPYRIN, A. N., Novosibirsk

[Abstract] Various laser Doppler velocity measurers (LDIS) with direct
spectral analysis are available for measuring supersonic two-phase streams,
a typical one using an LG-159 helium-neon laser (λ = 632.8 nm, P = 5 mW).
They are of the scanning type, and the tracking type. Confocal scanning
interferometers are simple in construction and ensure high luminosity, but
their time resolution is limited by such factors as pressure variations in
the test cell. The time resolution can be improved by use of a Fabry-Perot
etalon as a dispersing element with a constant free-dispersion region or
a cuniform Fizeau-Tolanskiy interferometer. A drawback of scanning inter-
ferometers is the "dead" time during measurements. Continuous measurement
is possible with a tracking system using such devices as a spherical inter-
ferometer or a cuniform multibeam Fizeau-Tolanskiy interferometer. Another
class of LDIS for measurement of fast processes are stroboscopic ones with
multiexposure photographic recording and optical processing of data by such
methods as space-spectrum analysis. The performance of such an instrument
is demonstrated on streams of particles moving at a velocity which does not
depend on their size and measurement of this velocity through three exposures
(bronze particles, mean diameter 50 μm) and two exposures (particles of
acrylic glass, mean diameter 200 μm). Most suitable as light source for these
instruments, generating short pulses at given repetition rates, are solid-
state lasers with Q-switching such as a ruby laser with a Kerr-effect
electrooptical modulator. Figures 2; references 19: 14 Russian, 5 Western
(1 in translation).
[61-2415]

MEASUREMENT OF SPATIAL CORRELATIONS WITH TWO-CHANNEL OPTICAL DOPPLER
ANEMOMETER

SMIRNOV, V. I. and TIMOFEYEV, A. S., Moscow

[Abstract] All optical Doppler anemometers can be classified into two
groups, each utilizing different statistics of the measured optical field
for determining the correlation between turbulent fluctuations in the medium.
Instruments of the first group analyze second-order statistics of the scattered
field and their operation is analogous to that of an astral Michelson inter-
ferometer. Instruments of the second group analyze fourth-order statistics
of the scattered field and their operation is analogous to that of a Braun-
Tviss interferometer. An instrument of the second type includes a special
correlator for averaging the product of light intensities at two points of
measurement, within a wide solid angle to ensure a high signal-to-noise
ratio. A special-purpose two-channel Doppler anemometer of the second type
has been developed for measuring the local velocity field and fluctuation
intensity as well as the spatial structure of a turbulent stream including
the various components of the velocity space-correlation tensor. It consists
of a coherent radiation source, a light beam splitter, an ultrasonic modula-
tor in one channel and a mirror followed by another ultrasonic modulator in
the other. Light beams are used which correspond to zero-order and first-
order diffraction, all the others are diaphragmed. A set of mirrors forms
two pairs of probing beams. The scanning system consists of a plane-parallel
plate rotating about its axis of symmetry and two half-lenses movable rela-
tive to one another. Each of the two receiver channels consists of a prism,
an aperture stop, an objective a field diaphragm, and a photoreceiver. The
method of measurement with this instrument is based on analysis of two spectra
similar to the probability density distributions of projections of two local
velocities on two mutually orthogonal sensitivity vectors. Figures 4;
references 6: 4 Russian, 2 Western (1 in translation).
[61-2415]

INSTRUMENT FOR MEASURING LOCAL VELOCITY WITH SCANNING-TYPE OPTICAL FREQUENCY
DISCRIMINATOR

BELOUSOV, P. Ya., Novosibirsk

[Abstract] An optical instrument for measuring local velocity has been
developed which uses a scanning frequency discriminator for analysis of the

scattered light and formation of the probing coherent optical signal, instead of a confocal interferometer continuously tracking the signal frequency and requiring complex electronic equipment for automatic frequency control. The performance of this instrument, with a continuously scanning multibeam interferometer used as the discriminator, is explained in terms of relations between laser beam intensity, probing signal, output signal, Doppler frequency shift and measured component of the velocity vector. Such an instrument built with a laser (0.2 mW), Rochon prism, confocal interferometer (200 mm), sawtooth-voltage generator, piezoceramic plate, aperture stop, phase plate, semitransparent mirror, scattered-light intensimeter, focusing lens, rotating disk as test object, tachometer generator, photoreceiver, integrator, and oscillograph has a linear range of 0-30 m/s. In the experimental determination of its discrimination characteristic the oscillograph beam was controlled vertically by the tachometer signal proportional to the disk speed and horizontally by the integrator output signal. The author thanks Yu. N. Dubnishchev for assistance. Figures 2; references 3: 2 Russian, 1 Western.
[61-2415]

EFFECT OF INTERFERENCE ON REFLECTION OF LASER BEAM POWER BY MULTILAYER RECEIVER

IVLEV, Ye. I.

[Abstract] Reflection of laser radiation power by a multilayer calorimeter-receiver is analyzed, assuming that each layer has uniform optical properties and that a strong "greenhouse" effect minimizes reradiation losses of absorbed long-wave energy. The receiver consists of a 0.2 cm thick quartz window in the front wall of a plane-parallel housing and two separate parallel plates, one 0.1 cm thick of NS-11 glass and one of black oxidized aluminum with a voltage coil around, immersed in flowing water as coolant between the window and the back wall of the housing. The power of reflected radiation is calculated on the basis of interference of beams reflected by each boundary, with the three-dimensional incident beam treated as a superposition of plane waves. The results reveal an almost uniform suppression of interference over a range of window wedge angles up to 10^{-5} rad for a Gaussian incident beam and up to 10^{-3} rad for a "normally" incident beam, also an almost constant reflection coefficient over the 0.4-1.2 μm range of wavelengths. The results can serve as basis for designing the calorimeter window. Figures 4; references 25: 21 Russian, 4 Western.
[91-2415]

CONFIGURATION OF CONTROLLING ELECTRIC FIELD FOR ELECTRO-OPTIC DEFLECTORS OF
LASER RADIATION

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Leningrad Polytechnic Institute

[Abstract] The configuration of gradient-type electro-optic deflectors is
considered which will ensure maximally linear field intensity components in
the cross section. The configuration of a quadrupole deflector with poly-
gonal cross section is relatively simple, but the field here is necessarily
distorted. Taking into account the anisotropy of dielectric properties,
the crystal dimensions are calculated which will minimize this distortion.
Analysis of the problem involves isotropization of the region with a plane-
parallel field and application of the Keldysh-Sedov method to the electric
potential in the plane of a complex variable. Expansion of the field intensity
gradient into a Taylor series in the vicinity of the center leads to a
system of algebraic equations with solutions which are unique and linear,
in the form of rational fractions, for the desired cross sections. Figures 1;
tables 1; references 6: 3 Russian, 3 Western.
[62-2415]

EFFECT OF FLUCTUATIONS IN MEDIUM ON DIFFRACTIONAL IMAGE OF FOCUSING SYSTEM

IVANOV, V. V., Moscow

[Abstract] The effect of fluctuations in a turbulent nonhomogeneous medium
on local measurements by optical methods in gas streams is evaluated for in-
struments with circular aperture and spherical aberration. Calculations
are made for a lens with focal length f placed at the origin or rectangular
Cartesian coordinates in the xy-plane at a distance d, within the Fresnel
zone, from a point source of radiation at wavelength λ on the z-axis. The
corresponding equation for the light intensity distribution, taking into
account diffraction by the lnes and refraction in a randomly nonhomogeneous
medium, has been solved numerically after prior simplifying expansion into a
Fourier-Bessel series and application of the Graf addition theorem. The
results reveal the dependence of the dimensionless normalized intensity at
the center of the diffractional image on the level of phase fluctuations in
a spherical wave and also the dependence of the characteristic dimension of

the diffraction spot as well as on the intensity at its center on the diameter of the lens aperture. They indicate that, in the case of a strongly fluctuating medium, the signal level at the output of a photoelectronic recording device can always be increased by widening the entrance aperture of the optical receiving instrument. Figures 3; references 5: 3 Russian, 2 Western (in translation).
[61-2415]

SOLID STATE CIRCUITS

PHOTOEMISSION IN CHARGE-COUPLED DEVICES BEYOND FUNDAMENTAL-ABSORPTION EDGE
FOR SILICON

KLYAUS, Kh. I., OVSYUK, V. N., RZHANOV, A. V., SERDYUK, Yu. N. and
CHEREPOV, Ye. I., Institute of Semiconductor Physics, Siberian Department,
USSR Academy of Sciences, Novosibirsk

[Abstract] The spectral characteristics of surface photoemission at the
$Si-SiO_2$ interface were studied in an experiment with photoexcitation of
three-phase charge-coupled devices operating in the storage mode, with three
transfer electrodes on a dielectric (SiO_2) layer on an n-Si substrate.
Dependence of the photocurrent on the d.c. bias voltage was measured with
the photoexcitation energy below 1.1 eV. Dependence of the photoemission
efficiency on the photoexcitation energy over the $0.6 < h\upsilon < 1.2$ eV was measured
at 230, 259, 270 K and the results compared with theoretical calculations
for 140 and 295 K. The experiment revealed that the photocurrent does not
depend on the bias voltage when the latter is lower than the planar-bands
level or higher than the threshold level but increases sharply when the
latter changes from the lower toward the higher of these two levels. The
impurity photoemission efficiency within the impurity range of absorption
is now evaluated, assuming a uniform density of surface states over the
forbidden band of the semiconductor and a sufficiently short time of hole
migration from under the biasing electrodes to the load electrode. The
coefficients of thermal electron and hole capture from allowed bands by
surface states as well as the cross sections for photon absorption during
photoemission of electrons from valence band to surface states and from
surface states to conduction band are all assumed to be independent of the
energy of thermal levels. The results reveal that to each temperature there
corresponds a threshold photon energy below which no hole photoemission
signal appears and above which the photoemission efficiency increases
linearly with the photon energy. The coefficients of thermal electron and
hole capture at the $Si-SiO_2$ do not differ much and are not smaller than

10^{-9} cm$^3 \cdot$s^{-1}. The basic results of this work were reported at the 7th All-Union Symposium on Electron Processes at the Surfaces of a Semiconductor at the Interface Semiconductor-Dielectric, held at Novisibirsk, June 1980. Figures 4; references 12: 6 Russian, 6 Western.
[66-2415]

NATURE OF EMISSION LINES OF UNDOPED GALLIUM ANTIMONIDE

AVERKIYEV, N. S., FILIPCHENKO, A. S. and CHAYKINA, Ye. I., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] A study was made of the p-GaSb emission spectrum at 4.2 K, with the two lines J_1 ($\hbar\upsilon$ = 777 meV peak) and J_2 ($\hbar\upsilon$ = 797 meV peak) comprising it, under strain. Measurements were made in order to determine the dependence of the degree of linear polarization in the photoluminescence spectrum on the magnitude and the direction of uniaxial strain. Specimens of p-GaAs crystals, undoped with a hole concentration p = $2 \cdot 10^{17}$ cm^{-3} and [100] or [111] orientation had been cut into 1 x 1 x 4 mm^3 parallelepipeds. Under longitudinal compression, excess charge carriers were excited with a beam from an LG-126 He-Ne laser focused to produce a power density of 6 W/cm^2. Recombinational radiation was detected with a PbS photoresistor and analyzed with an ST-50 monochromator on a grating of 600 lines/mm. Under compression, the J_1-line shifted toward higher energy and the J_2-line broadened with its maximum shifting toward shorter waves. The trend was similar under compression along the [111] axis and along the [100] axis, but in the latter case the J_2-line as well as the α-line were weaker. An evaluation of the pressure dependence of polarization, with the strain-potential constants as free terms, confirms that the J_1-line is associated with "conduction band - double acceptor" recombination and suggests that the J_2-line must be associated with the A^OE-complex (recombination of exciton bound to fine neutral acceptor). The nature of the α-line, appearing only at high pressures above $2 \cdot 10^3$ kgf/cm^2, could not be identified. The α-line could be tentatively associated with states linked to the L-minimum, but further study is needed in order to confirm this. Figures 3; references 8: 6 Russian, 2 Western.
[66-2415]

CHANGE IN STATIC CONDUCTIVITY OF n-InSb UNDER CONDITIONS OF ELECTRON-
PARAMAGNETIC RESONANCE AT SUBMILLIMETER WAVELENGTHS

GERSHENZON, Ye. M., FOGEL'SON, M. S. and KHALITOV, V. Yu., Moscow State
Pedagogical Institute imeni V. I. Lenin

[Abstract] An experimental study was made of the change in electrical
conductivity caused by electron-paramagentic resonance at submillimeter
wavelengths, specifically in n-InSb characterized by an anomalously high
g-factor so that EPR occurs already in weak fields. This material is also
of particular interest, inasmuch as a new mechanism of "jump" photoconductivity
has been discovered in it. Measurements were made with a submillimeter-wave
spectrometer using a backward-wave tube rated for 0.55-2 mm wavelengths.
Resonance was recorded over the $n = 5 \cdot 10^9 - 8 \cdot 10^{15}$ cm^{-3} range of concentrations
difference ($n = n_{donor} - n_{acceptor}$) at temperatures from 1.6 to 12 K in
electric fields of 0-0.75 V/cm intensity. The concentration dependence and
the temperature dependence of the EPR conductivity change signal is evaluated
by comparing the experimental results with estimates based on treating the
change in conductivity as a special case of photoconductivity, no other theory
being applicable or available. Such estimates are made for specimens with
high impurity concentration and for specimens with different types of impurity
conductivity. The discrepancy is smallest for specimens where "jump" im-
purity conductivity occurs. Figures 3; references 17: 10 Russian, 7 Western
(3 in translation).
[67-2415]

INTERIMPURITY ABSORPTION OF INFRARED RADIATION IN WEAKLY DOPED SEMICONDUCTORS

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[Abstract] Absorption of infrared radiation is analyzed which occurs because
of phonon-free direct electron transitions within pairs of vacant and occupied
impurity centers. The analysis is based on energy relations in a donor
impurity band with compensating acceptors. The absorption coefficient as a
function of the frequency of the applied electric field is calculated from
the integral of probability of such a pair existing in a unit volume, with
respect to the difference between the Coulomb electron energies in its two
nodes. Numerical calculations have been made through simulation on a digital

computer by the Monte Carlo method for degrees of compensation from 0.1 to 0.9, an analytical expression also being available for low degrees of compensation. The results agree closely with experimental data. The authors thank B. I. Shklovskiy and A. L. Efros for helpful suggestions. Figures 1; tables 2; references 14: 7 Russian, 7 Western.
[67-2415]

NEGATIVE DIFFERENTIAL PHOTOCONDUCTIVITY INDUCED IN INDIUM ANTIMONIDE BY MAGNETIC FIELD

MALYUTENKO, V. K., TESLENKO, G. I. and MALOZOVSKIY, Yu. M., Institute of Semiconductors, UkSSR Academy of Sciences, Kiev

[Abstract] Photoconduction and, for comparison, dark conduction current-voltage characteristics of InSb were measured at T = 170 K, of particular interest being the range of n-type negative differential photoconductivity induced by the magneto-concentration effect rather than by heating. The magnetic field crossing the electric field controls the total number of current carriers where their concentration increases with increasing electric field intensity while the probability of nonlinear recombination increases and the effective carrier life time decreases. Measurements were made on 40-100 μm thick n-InSb crystal specimens in a nonheating electric pulse field of intensities up to levels above the range of Schottky-Reed linear recombination (>40-50 V/cm), first without a magnetic field and then with one of 103 Oe intensity. One face of a plate specimen was polished mechanically for maximum surface recombination rate and its other face was etched in SP-4 solution for minimum surface recombination rate, the latter side being then illuminated with radiation from a He-Ne laser. Theoretical calculations for small-signal photoconductivity in crossing fields with strongly absorbed radiation impinging on the face with low surface recombination rate confirm that negative differential photoconductivity appears in at least two cases, namely when either Auger inverse cubic-law volume recombination or inverse square-law surface recombination takes place in a crystal in E and H fields oriented so that charge builds up at the illuminated surface. Figures 2; references: 3 Russian.
[67-2415]

RADIATIVE DEFECTS PRODUCED IN SILICON BY HIGH-ENERGY PARTICLES

DMITRIYEV, V. M., KOSMACH, V. F. and MOLCHANOV, V. M., Leningrad Polytechnic
Institute imeni M. I. Kalinin

[Abstract] Radiative defect buildup in silicon single crystals by light
nuclei with an energy of 100 or 400 MeV/nucleon was studied by computer
simulation of the processes occurring here. These include successive atom-
atom collisions, nuclear reactions (fission), elastic nucleon scattering
and Coulomb scattering. Three groups of primary particles (p, α, N) and
various secondary particles (p, d, α; Li, Be, B; C, N, O; F, Ne, Mg, Al,
Si) were considered. The numerical values obtained for the mean length of
disorder domains in silicon (24 Å) agree closely with available experimental
data (from 22 Å for pure silicon to 30 Å for proton-doped silicon). Tables 2;
references: 6 Russian.
[67-2415]

CALCULATING KINETIC CHARACTERISTICS OF HOLES IN INDIUM ANTIMONIDE IN STRONG
ELECTRIC FIELD BY MONTE CARLO METHOD

OSADCHIY, V. M. and LUCHININ, S. D., Institute of Semiconductor Physics,
Siberian branch, USSR Academy of Sciences, Novisibirsk

[Abstract] Kinetic characteristics of holes in InSb in electric fields up to
and exceeding 1500 V/cm at T = 77 K were calculated by the Monte Carlo method,
on the basis of the two-band model of the valence band. A parabolic dis-
persion law was assumed for heavy holes and the Kane law in the two-band
approximation was used for light holes. Because of the low population in
the band of light holes, the method of trajectory splitting could be applied
to analysis of their kinetics. Their population was found to decrease
further with increasing field intensity, because of an attendant increase of
the frequency of their transitions into the band of heavy holes and a decrease
of the frequency of reverse transitions. Intraband as well as interband
scattering by polar and nonpolar optical and strain acoustic phonons, also
by charged impurities with concentration $N_i = 3 \cdot 10^{14}$ cm^{-3}, were taken into
account. The field dependence of drift velocity was found to be qualitatively
similar for both kinds of holes; quantitatively the drift velocity of light
holes being 4-4.5 higher than that of heavy holes and at most one half that
of electrons. Figures 3; references: 7 Russian.
[67-2415]

ROLE OF SIZE EFFECT IN GLASSY CHALCOGENIDE SEMICONDUCTORS IN STRONG ELECTRIC
FIELD

KALMYKOVA, N. P., SMORGONSKAYA, E. A. and SHPUNT, V. Kh., Physico-Technical
Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] The behavior of glassy chalcogenide semiconductors in a strong
electric pulse field was studied, in a field sufficiently strong for elec-
tronic processes to become as pronounced as thermal ones. Transients of
pulse currents were measured from the instant offfield application to the
steep rise after turn-on. Single voltage pulses of 10^3 V amplitude and
10^{-2} s duration were applied to 70 μm thick "sandwich" specimens of
$Si_{12}Te_{48}As_{30}Ge_{10}$. Two sets of current electrodes were alternately used with
each specimen, one with a large area of $4 \cdot 10^{-7}$ m^2 and one with a small area
of 10^{-7} m^2. The experimental data have been processed in terms of Ohm's law
and Joule's law equations in finite differences, with the time period sub-
divided into n = 10 intervals. The unknown radial profiles of current
density and temperature were assumed to be rectangular at each instant of
time. For a material with specific heat c = $3.2 \cdot 10^6$ J/(m$^3 \cdot$K) and thermal
conductivity λ = $5 \cdot 10^3$ W/(m$^2 \cdot$K), the evolution of the high-temperature
channel is calculated in terms of current density, temperature, and cross-
sectional area as functions of time. The results confirm the validity of
the model of nonuniform current flow and heating in which both increase with
decreasing area of the electrodes and their distributions become more non-
uniform with time. The "size effect" is thus manifested in dependence of
channel parameters and, consequently, of switching parameters on the area
of the electrodes. Figures 3; references 8: 6 Russian, 2 Western.
[67-2415]

EFFECT OF LASER IRRADIATION ON ELECTROPHYSICAL PROPERTIES OF EPITAXIAL PbTe
FILMS

GORIN, Ye. A., BEREZHNAYA, I. A., GENERALOVA, D. A., YEMELIN, S. N. and
YANKO, G. I.

[Abstract] An experimental study was made of changes in concentration and
mobility of charge carriers in PbTe films produced by the "hot wall" epitaxial

process under vacuum and then irradiated by a neodymium pulse laser ($\lambda =$
$=1.06$ µm). These films were grown to a 2-5 µm thickness in the (111)-
plane of freshly cleaved BaF$_2$ single crystals. The specimens were heated
by laser radiation in the Q-switching mode with pulses of 100 ns duration
and energy densities from 0.2 to 0.8 J·cm^{-2}, above the melting threshold,
to avoid cracking of the BaF$_2$ surface layer and destruction of the PbTe
film by either Q-switching pulses of longer duration or quasi-continuous
free-emission pulses. Measurements were made on pure p-type specimens and
on specimens with copper or indium metallization films for doping by means
of the laser radiation. Irradiation at an energy density higher than
0.4 J·cm^{-2} was found to invert a p-PbTe film with 0.03-0.05 µm thick copper
metallization to an n-PbTe film, at 300 K as well as at 78 K. The experi-
mental data and theoretical calculations of the temperature profile produced
by a rectangular surface-absorbed laser pulse, with attendant superheating
of the material to 1500°C taken into account, indicate that fast local heat-
ing and cooling of the material results in formation of acceptor-type defects
in it. Figures 2; tables 1; references 10: 7 Russian, 3 Western.
[67-2415]

KINETIC THEORY OF LONGITUDINAL HALL EFFECT IN HIGH-FREQUENCY ELECTRIC FIELD

PANKRATOV, A. A. and EPSHTEYN, E. M.

[Abstract] A kinetic theory of the longitudinal Hall effect in semiconductors
has been constructed where nonlinearity of this effect is caused by heating
of charge carriers by the high frequency electric field. The frequency
dependence of this effect is also accounted for when that frequency becomes
comparable with or higher than the relaxation frequencies. The theory is
based on the kinetic equation for electrons (or holes) in two constant
fields, electric and magnetic, and a high-frequency electric field, also on
the classical Boltzmann equation with quantum effects disregarded. Scatter-
ing is assumed to be quasi-elastic. The components of the conductivity
tensor and then the Hall effect (ratio of values of Hall constant with and
without parallel high-frequency electric field respectively) are calculated
by the method of successive approximations, with the amplitude of the high-
frequency field in the quadratic approximation. The one component of the con-
ductivity tensor which vanishes in the phenomenological theory does not
vanish here when dispersion is included. The theory also establishes a
power-law dependence of relaxation time on energy. References: 3 Russian.
[67-2415]

QUANTUM OSCILLATIONS OF PHOTOCONDUCTIVITY IN SEMICONDUCTORS DURING ELECTRON
HEATING BY RADIATION

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[Abstract] Quantum oscillations of photoconductivity in semiconductors are
analyzed which occur during heating of electrons by light, considering that
the energy spectrum of electrons in a strong magnetic field acquires a dis-
crete (Landau) structure. Photoconductivity measurement under these condi-
tions is shown to be more advantageous, from the practical experimental
standpoint, than measurement of Shubnikov-deHaas oscillations of other
kinetic or thermodynamic coefficients, inasmuch as it makes possible modula-
tion and extraction of the oscillatory component of a semiconductor charac-
teristic as a function of the magnetic field intensity. Such measurements
were made on specimens of $Cd_x Hg_{1-x}Te$ (x $\sim$ 0.2), n-InSb and n-InAs (n =
= $5 \cdot 10^{15}$ - $5 \cdot 10^{17}$ cm^{-3}) at T = 4.2 K in a magnetic field of intensities not
exceeding 70 kOe produced by a superconducting magnet. The specimens are
irradiated by a light-emitting diode (λ = 0.93 μm), and LG-126 laser
(λ = 0.63, 1.15, 3.39 μm), and a CO_2-laser (λ = 10.6 μm), with the radiation
modulated by means of a mechanical chopper at frequencies up to 10 kHz. The
field dependence of the magnetoresistivity and its oscillatory transverse
component was determined, the latter being measured through compensation
of the linear component, also that of the useful photoconduction voltage
signal and the μ-photoconductivity. The method is quite sensitive and,
because equilibrium electrons are efficiently heated by hot photocharge
carriers, requires very low radiation power. Figures 2; references 8:
7 Russian, 1 Western.
[67-2415]

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ZERO-OVERSHOOT RESPONSE IN GATED DC ELECTRIC DRIVES WITH ON-OFF CONTROL

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Institute

[Abstract] An examination is made of the influence that the frequency of
zero-overshoot operation has on the limiting dynamic and static capabilities
of an on-off system for controlling a gated DC electric drive. A method is
proposed for calculating the parameters of such control systems with regard
to particulars associated with the final frequency of the zero-overshoot
operation. Analysis shows that the minimum permissible frequency of zero-
overshoot operation determines the limiting dynamic and static indices in an
on-off control system working in this mode. Figures 3; references: 2 Russian.
[34-6610]

SCIENTIFIC AND TECHNICAL RESEARCH IN ELECTRIC POWER: STATE OF ART AND
TASKS AHEAD

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Electromechanics and Power Engineering Section of Scientific and Technical
Council to USSR Ministry of Higher Educational Institutions, distinguished
promoter of science and engineering in the RSFSR, distinguished holder of
Lenin and State Prizes

[Abstract] Soviet electric power research and development are characterized
by the system approach to their three different but closely interrelated
aspects: scientific-technical, ecological (biospherical), and socio-
political. In the scientific-technical arena the main four tasks are devising
a universal methodology for solution of all problems in this complex cybernetic-
type system; devising for this purpose a new principle of inquiry based on
synthesis rather than analysis and aimed at controlling, adaptively if
possible, rather than demonstrating and explaining system performance;
providing an adequate mathematical apparatus; and utilizing all applicable
new means at disposal in the solution. Fulfillment of these tasks should
stimulate changes in design and forecasting procedures as well as faster
introduction of new equipment. Specific areas where this applies, where new
available possibilities should stimulate almost revolutionary changes in
concept and approach are a.c. electric power transmission, regulation of
reactive power with attendant alleviation of stability problems, selection
of voltage levels, choice between overhead and underground construction,
hardware design and manufacture, changeover from older to newer equipment,
and automation. The main three requirements for carrying out those tasks
are training of engineers to do the job, training of instructors to teach
the engineers, and targeting of the scientific research activities in higher
educational institutions toward the future. References: 31 Russian.
[63-2415]

EVALUATING DEGREE OF COHERENCE IN PHOTOLITHOGRAPHY PROJECTION SYSTEMS

GUREVICH, E. S., SHALAPENOK, A. A., LOPATENKO, V. Ye. and NISKOVSKIKH, B. F.

[Abstract] The authors determine the optimum degree of filling of the entrance
pupil of the object lens in raster systems of projection photolithography
which give fields of illumination 100-150 mm in diameter with nonuniformity
of 2-5%. In the illuminator used in the experimental part of the work, a
collector-condenser system illuminates the first raster, while the second
raster is located in the focus of the first, and is followed by a lens
system which produces a magnified image in the object plane. In this system,
the images of all lenses of the first raster are superimposed, giving the
required nonuniformity of 2-5%. Two parallel slits in an opaque screen in
the object plane produce an interference pattern from which the degree of
coherence between points in the centers of the slits can be determined. The
results show that the optimum degree of filling of the entrance pupil is
0.3-0.4 for elements measuring 1 μm, and 0.4-0.5 for elements smaller than
1 μm. It is concluded that the best illumination with minimum nonuniformity
is given be rasters of small lenses (3.5-4 mm in diameter) with the thinnest
possible separators, the entrance pupil of the objective lens being partly
filled, while the raster is completely filled with light from the source.
Observance of the proposed recommendations should give optical projection
systems for photolithography that can produce elements as small as 0.8-1 μm.
Figures 5; tables 2; references 10: 2 Russian, 8 Western.
[41-6610]

MECHANISM OF ELECTRICAL EXPLOSION OF CONDUCTORS

KRIVITSKIY, Ye. V. and KHAYNATSKIY, S. A., Planning and Design Office of
Electrohydraulics, UkSSR Academy of Sciences, Nikolayev

[Abstract] An analysis is made of the dynamics of adiabatic heating of a
conductor by high-density current ending in an explosion. The singular
part of resistivity predominant near the critical temperature T_c is considered
(where T_c determines the instant of explosion where conductivity vanished
because of destruction of the conductor). In this region, the temperature
dependence of resistivity is given by $\rho(T) = \rho_0(1 - T/T_c)^{-n}$. In addition to
this relation, the initial system of equations includes the equation of the
RLC discharge circuit and the equation of heat balance. The analysis is

based on analogy between the behavior of electrical conductivity in the vicinity of the critical temperature and the behavior of the order parameter in the theory of phase transitions of the second kind. A relation is derived for resistance of the conductor as a function of current and the threshold energy that determines the explosive nature of conductor destruction. The derived threshold condition that sets limiting values of circuit parameters for explosive destruction agrees well with experimental data, showing that the proposed thermal mechanism of explosion of conductors is based on effects analogous to critical phenomena. Figures 1; references: 14 Russian. [34-6610]

INVESTIGATION OF SUPERCONDUCTORS IN LOW-AMPLITUDE VARIABLE MAGNETIC FIELDS

MILOSHENKO, V. Ye., PANTELEYEV, I. N. and SHUNIN, G. Ye., Voronezh Polytechnical Institute

[Abstract] A method of torsional ostillations is used to study losses in superconductors caused by the action of alternating magnetic fields on cryoelectromechanical devices. In the experimental part of the work, a specimen in the form of a plate was secured to a string stretched between holders and forming a capacitor with a stationary electrode 0.1 mm away. This capacitor acted as a sensor for determining the logarithmic decrement and frequency of oscillations of the specimen. Frequencies used ranged from 50 to 1000 Hz, and the alternating field was set up in the specimen as a result of oscillations in a magnetic field of 0-$8 \cdot 10^4$ A/m. The proposed technique is sensitive enough to study losses in thin-film superconductive coatings down to 30 nm thick. The specimens were plates of niobium, vanadium, lead-indium alloys with different indium contents, and also films of these metals made by vacuum sputtering on sapphire and "polikor." Relations are derived for magnetic field dependences of the relative change in natural frequency and of $\delta = \Delta W / 2W_0$, where ΔW are losses per period, and W_0 is the total kinetic energy of a plate with given moment of inertia, oscillating with given amplitude and angular frequency. The specimens were studied in the normal and superconductive state with changes in the orientation of the magnetic field and the natural frequency of oscillations. The results show that the proposed method is an effective means of studying losses and the nature of penetration of an alternating magnetic field into a superconductor. Figures 4; references 9: 8 Russian, 1 Western. [34-6610]

ELECTROMAGNETIC WAVES IN THIN-FILM SUPERCONDUCTING LINES

NIKITINA, N. Ye. and OSTROVSKIY. L. A., Institute of Applied Physics,
USSR Academy of Sciences

[Abstract] A solution is presented for the problem of the drop of electro-
magnetic waves at superconducting layers of finite thickness. An analysis of
this makes it possible to single out two interesting cases of propagation of
electromagnetic waves in an open laminated structure. These are: 1) Non-
radiating rapid modes which are directed along a line and are analogous to
slow Sichart waves, but with a nonzero field at the outer surface; and
2) Leaky waves which represent another type of radiation from the line than
that considered in a 1970 report by C. S. Owen and P. J. Scalapino (J. Appl.
Phys., 1970, 41, p 2047). The following items are studied in the present
paper: 1) Reflection and refraction of electromagnetic waves in the case of
drop at a superconducting layer; 2) Leaky waves in thin-film superconducting
structure; and 3) Waves guided along layers. It is shown that the special
features of the propagation of electromagnetic waves in a structure which
includes a thin-film superconducting line are connected with the fact that
the shielding properties of a superconducting layer are determined by the
distribution of superconducting currents in them. In the quasi-statistical
case considered, the distribution depends on the nature of the nonuniformity
of the magnetic field along a normal to the layer. With determined angles
of drop of a wave, the layer is equivalent to an ideal conductor of a
diamagnetic. The effect of shielding is much less in the intervening region.
As a result the thin-film superconducting line with $\varepsilon_1 > \varepsilon_2$ possesses some
directional effect on the leakage of the nonuniform waves. With $\varepsilon_1 < \varepsilon_2$ the
structure in question does not have a sharply expressed directional effect and
with drop angles at the thin layer, which correspond to internal reflections,
sustains propagation along the line with an arbitrarily small thickness of
the film. References 7: 2 Russian, 5 Western.
[29-6415]

SELECTION OF POWER RATING AND SPACING OF COMPENSATING DEVICES FOR CRYOGENIC
ELECTRIC TRANSMISSION LINES

POSPELOV, G. Ye., doctor of technical sciences, professor, FEDIN, V. T.,
candidate of technical sciences, docent, and GONCHAROV, V. M., engineer,
Order of Labor Red Banner Belorussian Polytechnic Institute

[Abstract] The load capacity of cryogenic a.c. electric transmission lines
is determined essentially by the stability limit in parallel operation and
the stability limit for the superconducting state. The former constraint
requires compensation, which is considered here in the case of coaxial pairs
of phase conductors with columbium stannide as superconducting material. The
line operates without voltage drop when the voltage at both ends is maintained
at the same nominal level by compensators spaced symmetrically along the line.
Calculations based on voltage and current relations in such a circuit yield
first the maximum power transmittable without compensation as a function of
the distance and then the power of longitudinal compensation, as well as the
power of attendant transverse compensation, as functions of the nominal load
power at various line voltages. The results reveal that capacitive transverse
compensation is required at or near full load and inductive transverse com-
pensation is required near no load. Numerical data covering the load range
of 1-20 GW for cryogenic 50-500 km long 110, 220, and 330 kV lines indicate
that longitudinal compensation is required approximately every 250-200 km,
the closer spacing of compensators corresponding to higher line voltage.
Article submitted by Department (Kafedra) of Electrical Systems. Figures 4;
references: 3 Russian.
[63-2415]

OBJECTIVE LENS FOR FOURIER ANALYSIS OF LARGE-SCALE PHOTOGRAPHS

BELINSKIY, A. V., Moscow Institute of Engineers in Geodesy, Aerial
Photography and Cartography

[Abstract] An objective lens is proposed for use in the method of coherent
spatial filtration in which an immersion fluid is used as an element of the
optical system. Such an objective can be made equivalent to a three-lens
system by using glass and immersion fluid with different refractive indexes,
and by making the fluid-glass interfaces spherical. The objective operates

with linear magnification of -1, and has a symmetric optical system with parallel rays in the fluid and with pupil in the plane of symmetry. A formula is derived for calculating the radii of curvature in such a lens to give zero shperical aberration. The proposed method is used for calculating an immersion objective to operate with helium-neon laser emission. Resolution in the center of a frame measuring 180 x 180 mm is about 50 mm^{-1}. Minimum values of spherical aberration of higher orders are realized by using grades of glass with index of refraction of 1.63-1.69. Figures 2; tables 1; references: 2 Russian.
[41-6610]

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